

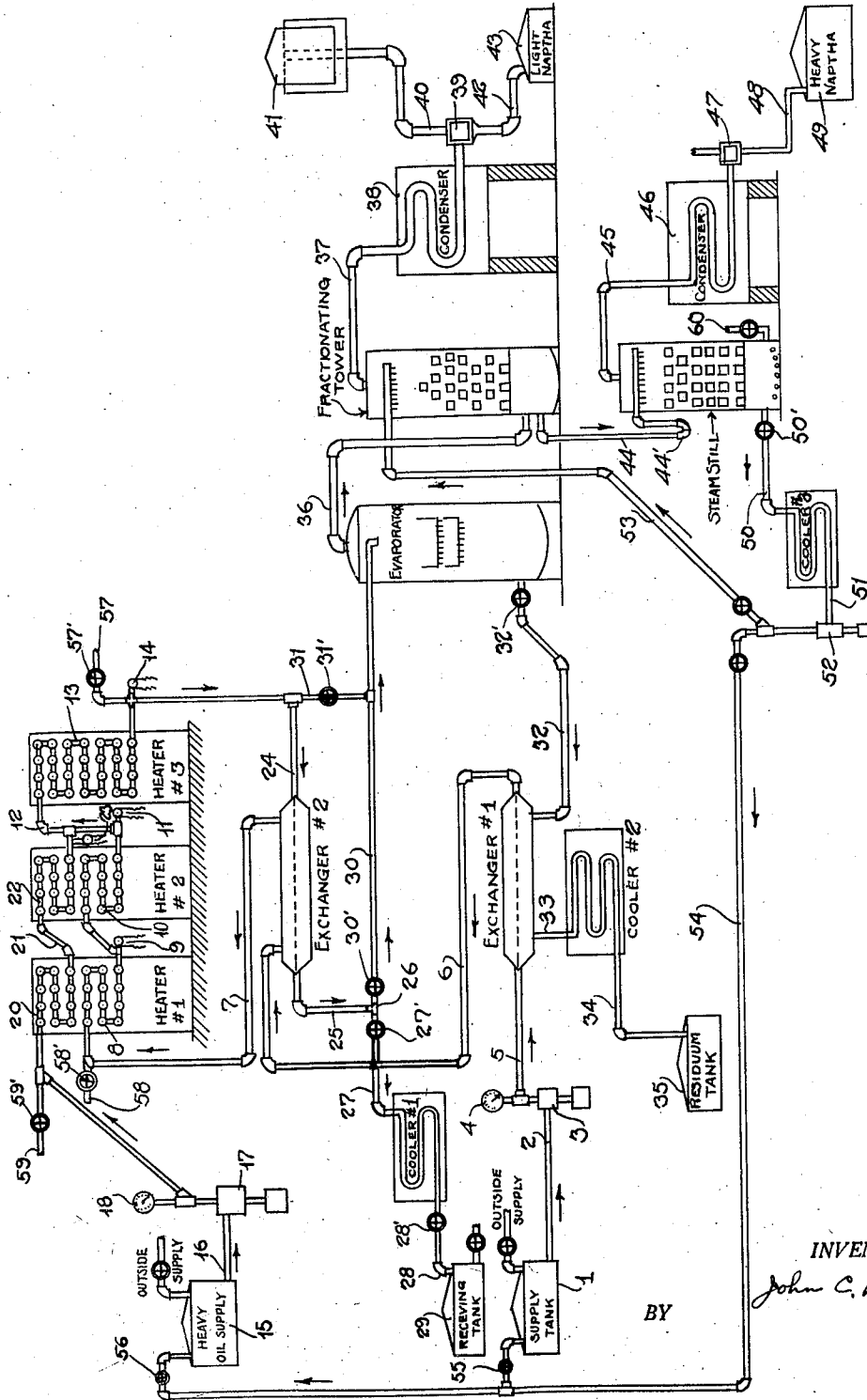
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PROCESS AND APPARATUS FOR THE TREATMENT OF HYDROCARBONS

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BY

UNITED STATES PATENT OFFICE.

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PROCESS AND APPARATUS FOR THE TREATMENT OF HYDROCARBONS.

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My invention relates to a process and apparatus to produce low boiling point hydrocarbons from those of higher boiling points and a method to produce a light cracking oil from a base stock or heavy oil such as fuel oil, residuum or crude oil or the like.

The present invention is an improvement over my previous Patent #1,456,419 but employs the same underlying principle of supplying the endothermic heat of reaction in a separately heated and controlled heating element whereby the cracking reaction is maintained at the maximum for the temperature employed.

My improved process of treating hydrocarbons consists in heating the hydrocarbons in a manner to produce the maximum decomposition products with a minimum expenditure of heat energy and under comparatively low temperature which is brought about by my method of supplying the endothermic heat of reaction in a heating element with an independently controlled heating means whereby the preheated hydrocarbons elevated to the optimum decomposition temperature are supplied with the heat of reaction and maintained at substantially the optimum decomposition temperature above referred to while passing through the reaction element which is so designed as regards volumetric capacity that the proper time element will be insured to bring about the maximum decomposition of the hydrocarbon at the temperature employed. This is accomplished by using a larger number of tubular elements in the reaction coil than I have used heretofore in the practical application of my Patent 1,456,419 and I am also enabled to eliminate the carbon precipitating chamber employed in the above patent. By using a large number of tubes in the reaction coil I am enabled to extend the reaction time where the hydrocarbons are given a prolonged heat treatment without diminution of the active supply of heat necessary to obtain the substantially maximum decomposition of the hydrocarbons for the temperature employed.

In this connection I have discovered that to heat the oil to be cracked to a temperature of active decomposition to obtain a yield of, say, 20 per cent of low boiling fractions, will require a temperature well above 800° F. if the oil, after passing through a heater is immediately cooled down; whereas if after heat-

ing the oil in the above mentioned heater and passing it to a secondary coil or what I denominate my reaction coil wherein heat is supplied to maintain its temperature and supply the endothermic heat of reaction, then the temperature of the oil may be reduced to 100° F. below the above mentioned temperature and still obtain a 20 per cent yield of low boiling fraction as illustrated above. It can be readily understood by those familiar with cracking that such a reduction of temperature for a given yield very often means the difference between practical and impractical operation for the reason that at the higher temperature the tubes are more highly heated, causing coking of the tubes and also a shorter life for the tubes and increases the liability of blow-outs with its consequent danger to life and property. Furthermore the plant can be kept on stream at the lower temperature a much longer time without shutdowns for cleaning and repairs, thereby reducing the cost of the products; there is also the advantage of a saving in fuel due to the lowered temperature of operation. To accomplish this purpose, I use a combination of fire heaters and heat exchangers, the heat exchangers are used as a feature of economy, employed to first preheat the hydrocarbons before they go to the fire heated preliminary tubular heating element where the desired heat of decomposition is attained or approximately so; from this heater the hydrocarbons pass to an additional separately fired and controlled heating element so designed as to permit the hydrocarbons to absorb the heat which is rendered latent by the decomposition or cracking reaction and to maintain or approximately so, its sensible heat. This secondary heating element or reaction coil is also of tubular form and is of such a volumetric capacity, in relation to the quantity of oil handled in any period of time, that as long a duration of time, as is consistent with economy or practicability, be permitted for the passage of the oil or hydrocarbon through the heater whereby the rate of decomposition is not reduced by diminution of temperature and the optimum decomposition or cracking of the hydrocarbons is obtained thereby.

In practice, I use a preliminary fire heater having steel or alloy steel tubes of three or four inches in diameter and numbering one

hundred more or less, connected in series, and the secondary or reaction coil is constructed of similar tubing of approximately the same size and number although, as previously intimated, this coil should be constructed to permit of a long time duration to obtain the optimum decomposition reaction; also to obtain a sufficiently high rate of speed to materially reduce the deposition of carbonaceous material in the tubes.

In my present invention I employ three separately fired furnaces each of which has a definite function to perform, besides the furnaces are heat exchangers, pumps; tanks; distilling equipment, fractionating apparatus; condensers; coolers, etc., all of which go to make up a complete plant for the economical operation of the process. However, the furnaces or converters are the essential portion of the apparatus and the oil leaving them could be handled in many ways well known to the refining industry that would produce the products manufactured by this process. I have shown a complete plant wherein this raw oil is introduced into the system and finished oil taken out up to the limitation of the equipment employed, this is done in order to make the process clear and understandable to those familiar with the art with which this process pertains.

In this process, I employ two systems of cracking so combined as to produce hydrocarbons of low boiling point and also intermediate fractions that can be recirculated for further cracking also a residuum suitable for fuel oil purposes or for further distillation in other distilling equipment.

This process is so arranged that so-called gas oil or light cracking stock may be charged into the apparatus or a heavy oil may be used as the raw incoming oil or combination of the two may be used, that is if the refiner had an excess of gas oil on hand, he could charge it into the system through the heavy oil supply tank or it could be introduced into the gas oil supply tank, or heavy oil could be introduced through the heavy oil supply tank and gas oil through the gas oil supply tank, so regulating the amounts that a balance in the various stocks may be made, as will be more particularly described below. This being a continuous process I prefer to supply for the makeup oil an oil that may by distillation produce the light cracking oil or that will do so after passing through a cracking reaction whereby the heavy hydrocarbons are altered in their composition. Some of the products resulting from this cracking of the makeup oil will be the desirable low boiling point hydrocarbons and others will be suitable to be passed through the light oil cracking portion of the apparatus to produce on decomposition the desirable low boiling hydrocarbons.

In one of my previous patents I described

a process wherein decomposition or conversion of the hydrocarbons largely takes place in an enlarged chamber or digester, the heating of the oil taking place in a coil heater and the oil being discharged from such coil into the reaction chamber. Now I have found that a better conversion will take place if the oil is passed through a secondary heating coil wherein the temperature is maintained at the maximum temperature employed in the operation and wherein the endothermic heat of reaction may be supplied without absorbing it from within the oil itself as is the case where a large reaction chamber is employed and which is not supplied with heat. The reason for this is that the conversion rate drops very rapidly with decreasing temperature which is the case where a large conversion chamber is employed and where additional heat is not supplied to maintain its temperature against radiation and heat absorption in the endothermic reaction.

To overcome this defect I employ a separately fired and controlled heating element wherein the hydrocarbons are maintained at the active rate of decomposition at the maximum temperature attained by the hydrocarbons in passing through the heating elements, in this manner the conversion rate is upheld and the maximum yield obtained before the hydrocarbons are discharged for subsequent treatment.

The pressures used in this process are substantially those used in my Patent 1,426,813. By maintaining these high pressures vaporization is prevented and this, together with the rapid flow of liquid through the tubes prevents material deposition of carbon in the tubes.

Referring to the single sheet of drawings 1 represents a light cracking oil supply tank, 2 a suction pipe to the pump 3; 4 a pressure gauge on the pump discharge pipe 5 which connects to heat exchanger #1; pipe 6 connects heat exchanger #1 to heat exchanger #2 and pipe 7 connects heat exchanger #2 to the inlet tubing of heater #1. 8 is the light oil heating element of heater #1 and 9 is a pyrometer on the outlet of said heating element. 10 is the light oil heating element of heater #2 and 11 is a pyrometer on the outlet thereof; 12 is a connecting pipe from the coils in heater #2 to the inlet of the coil in heater #3; 13 is a heating coil or element in heater #3 and 14 is a pyrometer on its outlet; 15 is the heavy oil supply tank; 16 is a connecting pipe to the pump 17; 18 is a pressure gauge on the discharge pipe 19 which connects with the heavy oil heating coil 20; 21 is a connecting pipe between the heavy oil heating coil 20 and the heavy oil heating coil 22 in heater #2; 23 is a pyrometer located on the outlet of coil 22. The outlet of coil 22 connects with pipe 12. 24 is a connection from the outlet of coil 13 to heat exchanger

#2 and 25 is its outlet connecting to the pipe 26 which has one branch 27 and valve 27' connecting to a cooler #1 which in turn has an outlet 28 and valve 28'; pipe 28 connects to a receiving tank 29, 26 has a second branch 30 and valve 30' which forms the supply pipe connecting to the evaporator; 31 is a bypass pipe between pipe 24 and pipe 30, and 31' is a valve in pipe 31; 32 is a residuum draw-off pipe connecting the evaporator to heat exchanger #1 and 32' is a valve in pipe 32; 33 is the outlet pipe connecting heat exchanger #1 to cooler #2; 34 is a pipe connecting cooler #2 to the residuum tank 35; 36 is a vapor pipe connecting the evaporator to the fractionating tower; 37 is a vapor pipe connecting the fractionating tower to the condenser 38, the outlet of the condenser connects with the look box 39 from which is connected a pipe 40 connecting with a gas holder 41, also from the look box 39 is connected a rundown pipe 42 connecting to the light naphtha tank 43. From the bottom of the fractionating tower is connected a pipe 44 and trap 44' connecting to the spray inlet of the steam still. 45 is a vapor pipe connecting the steam still to the condenser 46, the outlet of which connects with the look box 47 which in turn has a rundown pipe 48 connecting with the heavy naphtha tank 49. From the bottom of the steam still is connected a pipe 50 and valve 50' connecting to cooler #3 the outlet 51 of which connects to the pump 52. The pump has two discharge pipes one of which 53 connects to the spray pipe in the fractionating tower, and 54 connects to the supply tank 1 through pipe 55 and to heavy oil supply tank 15 through pipe 56. At the outlet of coil 13 is connected a water pipe 57 controlled by a valve 57' to furnish water for purging the two systems of oil and to wash out carbonaceous accumulations in the coils. If coils 8 and 10 are being purged then the purged material is discharged through pipe 58 and valve 58' and if coils 20 and 22 are being purged then the purged material discharged through pipe 59 and valve 59'. 60 is a steam connection to the steam still.

Having now described my apparatus, I will describe its operation. We will assume the tank 1 is supplied with light cracking oil and tank 15 with heavy cracking oil and that the system is in operation; it being a continuous process, I will describe it while in operation as it is more easily understood than if I undertook to describe its starting operation:

The pump 3 is taking its supply of oil through pipe 2 from the light oil supply tank 1 which may be supplied with said light oil from an outside source or from within the system by passing thereto the residue of the steam still as shown on the drawing. The pump 3 discharges the light cracking oil through pipe 5 to one side of the heat ex-

changer #1 from which the oil picks up heat derived from the outgoing hot residuum flowing from the evaporator. From the exchanger #1 the partially heated oil now passes to exchanger #2 from which it picks up additional heat derived from the hot outgoing cracked oil issuing from heater #3; the heated oil now passes to the light oil heating coil 8 in which it is heated further to a point where active cracking takes place and in which it attains or approximately so, its maximum temperature. This temperature is indicated by the pyrometer 9. The highly heated oil now flows to heating coil 10 wherein the maximum temperature of operation is maintained or approximately so. In coil 10 sufficient heat is supplied to offset heat losses due to radiation and the absorption of heat by the endothermic cracking reaction. The temperature of the oil leaving coil 10 is indicated by the pyrometer 11. The oil now flows through the pipe 12 which connects to the inlet of coil 13. During its progress through the two heaters the oil is subjected to a sustained and prolonged cracking temperature and if the coil capacity is properly designed, I will get the maximum yield of low boiling point fractions at the temperature employed. While the oil is passing through the system a pressure is maintained sufficient to prevent material vaporization of the oil, this pressure being maintained by the pump 3 up to the point of discharge through valves 30' 31' or 28'.

While the light cracking oil is passing through the heating coils 8 and 10 the pump 17 is pumping heavy oil from the supply tank 15 to the heating coil 20 which picks up heat from the gases issuing from around the heating coil 8. The oil now passes through pipe 21 into the heating coil 22 and picks up heat from heater #2 as it did in heater #1, its temperature being observed by the pyrometer 23 and is regulated by the quantity pumped through the coil, or it may be further regulated by having the coil set above an upper fire-box so that additional heat may be supplied if so desired. I have not shown this arrangement but anyone familiar with tubular still construction can readily understand and apply it. The oil leaving coil 22 now enters the pipe 12 and commingles with the oil issuing from coil 10 from which it picks up additional heat, for in practice, the oil leaving coil 10 will usually have a temperature from 750 to 900 or above and that leaving coil 22 from 600 to 750. For this reason, the temperature of the mixture will be a mean between the two temperatures. The admixed oils will now pass to the heating coil 13 set in heater #3 wherein their temperature may be maintained at their entering temperature or they may be given a higher temperature so that increased cracking of the heavy oil will take place

thereby producing low boiling point hydrocarbons and also those required for the light cracking oil system supplied from tank 1. If the heavy oil is such that a sufficient quantity of the light cracking oil is naturally contained therein to supply the deficiency in the light oil cracking system, it would not be necessary to heat the mixture of oils, passing through coil 13 to an active cracking temperature but only to such a degree as to distill those fractions upon release into the evaporator. Instead of using heavy oil a light oil like steam still bottoms may be used. This may be admixed with the heavy oil in tank 15 or run separately.

The pressure on the pump 17 is made sufficiently high to force the oil through the heating elements and into the pipe 12 so that this pressure is sufficient to prevent any material vaporization of the oil for the reason that the pump 3 is maintaining a pressure in the light cracking oil system sufficient to prevent material vaporization and pipe 12 is the mixing pipe common to both systems. After leaving coil 13, the oil heated to the proper temperature as observed by pyrometer 14 passes to the heat exchanger #2 wherein some of its heat is transferred to the ingoing uncracked oil, the amount passing through exchanger #2 may be regulated by the bypass 31 and valve 31' and valve 30'. The oil passes into pipe 30 under reduced pressure and discharges into the evaporator where evaporation of the volatile fractions takes place, the vapors passing out through vapor pipe 36 into the fractionating tower and the residuum precipitates to the bottom of the evaporator and is withdrawn through pipe 32 and valve 32' through the heat exchanger #1 from whence it goes to cooler #2 and is discharged through pipe 34 into the residuum tank 35. The vapors entering the fractionating tower are fractionated therein, the heavier fractions are condensed and are assisted in their condensation by a spray of cooled oil obtained from the bottom of the steam still. This residual steam still bottom is in turn obtained by the distillation of condensate from the fractionating tower. The condensation products of the fractionating tower enter the steam still through pipe 44 and vapor trap 44'. The residual products from the steam still are drawn off through pipe 50 and valve 50' through the cooler #3 from which they pass by pipe 51 to the pump 52. There are two discharges to pump 52, one branch 53 connects to the oil spray pipe in the fractionating tower to perform the functions above described of supplying a cooled condensing medium; the other branch 54 conducts the excess steam still residue not used for condensing purposes to the supply tank 1 through the pipe connection 55, and such residue may also be discharged into tank 15 through pipe 56. It is this oil derived

from the condensation products of the fractionating tower and subsequently steam still residue and which forms the steam still residue that goes to furnish the light cracking oil in tank 1 of the light oil cracking system, but which is primarily obtained from the cracking and distilling of the heavy oil in the heavy oil cracking system which is supplied from tank 15. If the two systems are properly balanced there will be sufficient light cracking oil obtained from the heavy oil introduced into the system from tank 15 to compensate for the extraction of light and heavy naphtha going to the tanks 43 and 49 and also to compensate for the gas loss going to gas holder 41. In this manner the makeup oil is supplied to the heavy oil tank 15 and may consist of fuel oil, crude oil, gas oil, residues or slop oils, all of which may be worked through the heavy oil cracking system and will produce a stock suitable to be cracked in the light oil cracking system wherein the major cracking operation is done. The heavy oil cracking system will also supply a portion of the desirable low boiling point fractions going to tanks 43 and 49, the principal function, however, is to supply the light cracking oil in the manner above described.

The light vapors not condensed in the fractionating tower are conducted by vapor pipe 37 to the condenser 38 wherein the condensible fractions are separated from the gases or non-condensable fractions, these are separated in the separator or look box 39, the gases going to the gas holder 41 and the condensate to tank 43 through pipe 42. The condensation products leaving the fractionating tower through pipe 44 into the steam still will contain certain low boiling point fractions that are re-vaporized therein, the vapors of which are conducted through vapor pipe 45 to the condenser 46 and there condensed, and they then pass through the look box 47 and pipe 48 to the heavy naphtha tank 49.

The heavy naphtha may be disposed of as such or it may be used as a blending stock or as a solvent naphtha as desired.

If in starting up the heaters, the oil leaving coil 13 is not suitable for passing to the evaporator, it may be discharged through valve 27' and through pipe 27 to cooler #1 and through valve 28' and pipe 28 to the receiving tank 29.

From the foregoing it is seen that this process is a self contained one and can convert heavy oils and residues as well as lighter oils into new products not previously contained in them.

It is a well known fact that the various hydrocarbons have definite cracking temperatures. As a rule the lighter hydrocarbons require a higher temperature to crack them than do the heavier hydrocarbons, and for this reason it is not desirable or practical to endeavor

to crack a mixed stock where there is a wide difference in the characteristic of the oils making up the mixture. For instance, the best results will not be obtained if a fuel oil or a crude oil is cracked along with a gas oil or distillate for if the proper temperature to crack the fuel oil is used it will not be sufficiently high to effectively crack the gas oil or distillate, especially if the distillate is one that has previously gone through a cracking operation and is being recycled for further cracking. Likewise if a higher temperature is used where effective cracking of the lighter hydrocarbons will be obtained then this higher temperature will cause excessive decomposition of the heavier hydrocarbons with consequent larger production of carbon or carbonaceous material which will foul the apparatus requiring frequent cleaning with consequent shutdowns and loss of capacity.

In this process I use oils of very dissimilar characteristics but I so arrange the apparatus that the cracking of the different oils will take place at temperatures best suited for their economical handling whereby I obtain a minimum of carbon or carbonaceous material and still obtain yields of the low boiling point hydrocarbons in commercial quantity. To accomplish this I employ two separate cracking systems, one operating at a higher temperature than the other, the former or what I denominate the light oil cracking system is designed to handle light oils or distillates derived from an outside source or from within itself as a recycle stock, this system being operated at a temperature sufficiently high to economically crack these light oils. The latter system which I denominate the heavy oil cracking system operates at a lower temperature best suited to crack the heavier hydrocarbons without excessive formation of carbon or carbonaceous material and I so combine the two systems that I utilize the high heat content of the hydrocarbons from the light oil cracking system to produce the cracking temperature for the heavier hydrocarbons, the combined or admixed hydrocarbons then passing through a heat supplying furnace where proper regulation of the temperature may be made and where the endothermic heat of reaction may be supplied. The light oil cracking system likewise has a regulated heat supplying furnace within its own system whereby the heat of reaction is supplied, these finishing furnaces at the same time supplying the means for the proper time factor of reaction.

By this process excessive cracking of the heavier hydrocarbons is obviated. The pressure required to prevent vaporization of the hydrocarbons is less than must be employed to prevent vaporization in single cracking systems, that is, the pressure imposed by the pump upon the two tube systems may be re-

duced and still be sufficient to prevent any material vaporization of the hydrocarbons due to the reduced vapor pressure prevailing in the double cracking system.

What I claim as new is:

1. A process for the production of low boiling point hydrocarbons from those of higher boiling point comprising heating, said higher boiling hydrocarbons in a series of tubular heaters wherein heat is supplied to bring said higher boiling hydrocarbons to an active cracking temperature in a primary heating element, then subjecting said higher boiling hydrocarbons to a prolonged heat treatment in a secondary tubular heating element wherein the temperature attained in the primary heating element is maintained by supplying to the hydrocarbons heat sufficient to compensate for the heat rendered latent by the endothermic reaction of decomposition and also for the heat lost by radiation whereby the maximum rate of decomposition for the temperature employed is obtained, then admixing the heated hydrocarbons with an additional supply of hydrocarbons at a relatively lower temperature then subjecting the admixed hydrocarbons to a final heat treatment whereby the mixture of hydrocarbons is subjected to an active decomposition temperature, and maintaining on the hydrocarbons, a pressure sufficient to prevent material vaporization thereof.

2. A process for the production of low boiling point hydrocarbons from those of higher boiling point comprising heating said higher boiling hydrocarbons in a series of tubular heaters wherein heat is supplied to bring said higher boiling hydrocarbons to an active cracking temperature in a primary heating element, then subjecting said higher boiling hydrocarbons to a prolonged heat treatment wherein the temperature attained in the primary heating element is maintained by supplying to the hydrocarbons heat sufficient to compensate for the heat rendered latent by the endothermic reaction of decomposition and also for the heat lost by radiation, whereby the maximum rate of decomposition for the temperature employed is obtained, then admixing the heated hydrocarbons with an additional supply of hydrocarbons at a relatively lower temperature, then subjecting the admixed hydrocarbons to a final heat treatment whereby the mixture of hydrocarbons is subjected to an active decomposition temperature, and maintaining on the hydrocarbons, a pressure sufficient to prevent material vaporization thereof, then reducing the pressure and discharging the hydrocarbons into a fractionating apparatus, permitting the lighter hydrocarbons to vaporize, then fractionating them, separating the low boiling point fractions, and condensing them,

condensing the higher boiling point fractions and returning them to be re-cracked in a cycle of operations.

3. A process of cracking oil which comprises heating a relatively light hydrocarbon oil in a continuous tubular heating element to an active cracking temperature, then subjecting said relatively light hydrocarbons to a further heat treatment in a tubular heating element for a prolonged period of time and supplying therein additional heat thereto to compensate for the heat rendered latent in the decomposition reaction and that lost by radiation whereby the maximum yield of low boiling point hydrocarbons will be produced at the temperature employed, and simultaneously heating a relatively heavier hydrocarbon oil to a temperature which upon admixture with the heated lighter hydrocarbon oil will produce a temperature in the mixture sufficient to crack the heavier hydrocarbons, then subjecting the mixture to a prolonged heat treatment at the temperature attained on admixture in a tubular heating element wherein the endothermic heat of reaction together with the heat lost by radiation is supplied whereby active decomposition will be maintained and the maximum economical yield of decomposition products obtained, and maintaining upon the hydrocarbons an impressed pressure sufficient to prevent material vaporization thereof.

4. A process of cracking oil which comprises heating a relatively light hydrocarbon oil in a continuous tubular heating element to an active cracking temperature, then subjecting it to a further heat treatment in a tubular heating element for a prolonged period of time and supplying therein additional heat to compensate for the heat rendered latent in the cracking reaction and that lost by radiation whereby the maximum yield of low boiling point hydrocarbons will be produced at the temperature employed, and simultaneously heating a heavier hydrocarbon oil to a temperature which upon admixture with the heated lighter hydrocarbon oil will produce a temperature in the mixture sufficient to crack the heavier hydrocarbons, then subjecting the mixture to a prolonged heat treatment at, at least, substantially the temperature attained on admixture in a tubular heating element wherein the endothermic heat of reaction is supplied together with the heat lost by radiation whereby active cracking will be maintained and the maximum economical yield of decomposition products obtained and maintaining upon the hydrocarbons an impressed pressure sufficient to prevent material vaporization thereof, then reducing the pressure and discharging the hydrocarbons into a fractionating apparatus permitting the lighter hydrocarbons to vaporize; fractionating them, separating the low boiling point fractions and returning the higher boiling

point fractions to be re-cracked in a cycle of operations.

5. A process of cracking oil which comprises heating hydrocarbon oil in a continuous tubular heating element to an active cracking temperature, then subjecting said heated oil to a further heat treatment in a tubular heating element for a prolonged period of time and supplying therein additional heat thereto to compensate for heat rendered latent in the cracking reaction and that lost by radiation whereby the maximum yield of low boiling point hydrocarbons will be produced at the temperature employed, and simultaneously heating a relatively heavier hydrocarbon oil to a temperature which upon admixture with the heated lighter oil will produce temperature in the mixture sufficient to crack the heavier hydrocarbons, then subjecting the mixture to a prolonged heat treatment at, at least, substantially the temperature attained on admixture in a tubular heating element wherein the endothermic heat of reaction is supplied together with the heat lost by radiation whereby active decomposition will be maintained and the maximum economical yield of decomposition products obtained and maintaining upon the hydrocarbons an impressed pressure sufficient to prevent material vaporization thereof, then reducing the temperature, then reducing the pressure and discharging the hydrocarbons into a fractionating apparatus, permitting the low boiling fractions to vaporize, then condensing them.

6. An apparatus for cracking different species of hydrocarbons comprising a source of supply for one species, a heater and a pump and connections for forcing the hydrocarbons through the heater, a second source of supply for the second species of hydrocarbons, a second heater, a pump and connections for forcing the hydrocarbons through the second heater, a third heater and connections between the first and second mentioned heaters to the third heater for commingling the two species of hydrocarbons whereby one species of hydrocarbons may be passed through the first heater at a different temperature from the temperature of the other species of hydrocarbons and the two species mixed and passed through the third heater at a cracking temperature.

7. An apparatus for cracking hydrocarbons comprising a source of supply of hydrocarbons, a pump, a heat exchanger and a plurality of heaters with connections therebetween, an evaporator with pipe connections between the last heater and the evaporator, a fractionating tower connected to the evaporator, a still connected to the fractionating tower and a pump with a suction side connected to the bottom of said still and the discharge side connected with the upper portion of the fractionating tower.

8. A hydrocarbon cracking and distilling apparatus comprising a heater for cracking hydrocarbons, a fractionating tower with connections between the heater and the bottom of the fractionating tower, a still connected to the bottom of the fractionating tower and a pump with the suction side connected with the bottom of the still and its discharge side connected to the upper portion of the fractionating tower whereby oil may be withdrawn from the bottom of the still and discharged in the top of the fractionating tower.

9. An apparatus for cracking hydrocarbons comprising a plurality of heaters, a source of supply and a pump for forcing the hydrocarbons from the source of supply through the heaters, an evaporator connected to the heaters, a fractionating tower connected to the evaporator, a steam still connected to said fractionating tower and a second pump for withdrawing the hydrocarbons from the bottom of the still and discharging them in the top of the fractionating tower.

10. A process for the decomposition of high boiling hydrocarbon oils to form low boiling hydrocarbon oils which comprises independently preheating a relatively high boiling point oil to raise it to its cracking temperature, independently preheating a relatively low boiling point oil to raise it to its cracking temperature, intermingling the said preheated oils, continuing the heating of said mixed oils to crack the same, and separating the low boiling hydrocarbons formed by the cracking reaction.

11. A process for the decomposition of high boiling hydrocarbon oils to form low boiling hydrocarbon oils which comprises independently preheating a relatively high boiling point oil to raise it to its cracking temperature, independently preheating a relatively low boiling point oil to raise it to its cracking temperature, intermingling the

said preheated oils, continuing the heating of said mixed oils to crack the same while maintaining the oil under a pressure sufficient to prevent substantial vaporization, and separating the low boiling hydrocarbons formed by the cracking reaction.

12. A process of cracking oil which comprises heating hydrocarbon oil in a continuous tubular heating element to an active cracking temperature, then subjecting said heated oil to a further heat treatment in a tubular heating element for a prolonged period of time and supplying additional heat thereto to compensate for heat rendered latent in the cracking reaction and that lost by radiation, whereby the maximum yield of low boiling point hydrocarbons will be produced at the temperature employed, and simultaneously heating a relatively heavier hydrocarbon oil to a temperature which upon admixture with the heated lighter oil will produce a temperature in the mixture sufficient to crack the heavier hydrocarbons, mixing the heated oils, then subjecting the mixture to a prolonged heat treatment at, at least, substantially the temperature attained on admixture in a tubular heating element wherein the endothermic heat of reaction is supplied together with the heat lost by radiation, whereby active decomposition will be maintained and the maximum economical yield of decomposition products obtained, and maintaining upon the hydrocarbons an impressed pressure sufficient to prevent material vaporization thereof, then cooling the mixture of cracked hydrocarbons to a sufficient degree to prevent vaporization of the desired light hydrocarbons upon release of the imposed pressure, then releasing the pressure and discharging the cooled hydrocarbons into storage for subsequent treatment.

In testimony whereof I affix my signature.
JOHN C. BLACK.